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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re the Application of

Sharma et al.	Art Unit: 2625
Application No.: 10/044,468	Examiner: Thompson, James A.
Filed: January 11, 2002	Docket No.: A1160-US-NP
	XERZ 2 00445
For: SYSTEM AND METHOD OF HALFTONING MULTI-PASS RENDERING	

MAIL STOP Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

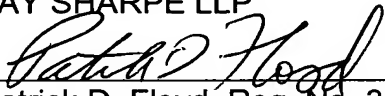## TRANSMITTAL OF
APPEAL BRIEF UNDER 37 C.F.R. § 41.37
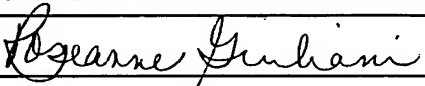
Dear Sir:

Applicant transmits herewith one (1) originally signed copy of APPEAL BRIEF UNDER 37 C.F.R. § 41.37 for the above-reference patent application.

Payment in the amount of $500.00 for the filing of this Appeal Brief is authorized to be charged to Deposit Account No. 24-0037.

Respectfully submitted,

FAY SHARPE LLP

_____
Patrick D. Floyd, Reg. No. 39,671
1100 Superior Avenue, Seventh Floor
Cleveland, OH 44114-2579
216-861-5582

February 20, 2007
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTOR(S)	:	Sharma et al.
TITLE	:	**SYSTEM AND METHOD OF HALFTONING FOR MULTI-PASS RENDERING**
APPLICATION NO.	:	10/044,468
FILED	:	January 11, 2002
CONFIRMATION NO.	:	9895
EXAMINER	:	Thompson, James A.
ART UNIT	:	2625
LAST OFFICE ACTION	:	August 16, 2006
ATTORNEY DOCKET NO.	:	A1160-US-NP XERZ 2 00445

<u>RULE 37 C.F.R. §41.37 APPELLANT'S BRIEF</u>

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This Appeal Brief is in furtherance of the Notice of Appeal that was filed in this case on December 18, 2006.

The fees required under 37 C.F.R. §1.17 and any required petition for extension of time for filing this Brief and fees therefore are dealt with in the accompanying Transmittal of Appeal Brief.

Appellant files herewith an Appeal Brief in connection with the above-identified application wherein claims 1-21 were finally rejected in the final Office Action mailed August 16, 2006. What follows is Appellant's Appeal Brief (submitted in triplicate) in accordance with 37 C.F.R. §1.192(a).

I.   Real Party in Interest (37 C.F.R. §1.192(c)(1))

The real party in interest in the subject Appeal is Xerox Corporation of Stamford, Connecticut, the assignee of record for this patent application.

II.   Related Appeals and Interferences (37 C.F.R. §1.192(c)(2))

There are no other applications involved in an appeal or interference before the U.S. Patent and Trademark Office from which the present application bases its priority, or any case which bases its priority upon the present application that will directly affect or will be directly affected by, or will have a bearing on the Board's decision in this Appeal.

III.   Status of Claims (37 C.F.R. §1.192(c)(3))

The status of the claims set forth after the final Office Action mailed August 16, 2006 was and is as follows: allowed claims: **none**, rejected claims: **1-31**. The present Appeal is directed specifically to independent claims 1, 25 and 28 and dependent claims 2-24, 26-27, and 29-31.

IV.   Status of the Amendments (37 C.F.R. §1.192(c)(4))

No Amendments were made.

V.   Summary of the Invention (37 C.F.R. §1.192(c)(5))

The present application is directed to a system and method for halftoning for multi-pass rendering suitable for multi-pass printing.

The disclosed embodiments can apply to a system for multi-pass rendering shown generally at **200** in Figure 13.   An input image forming an electronic representation of an original document is directed to an image processing unit (IPU) **204** to be processed. The IPU **204** produces an output image rendering suitable for printing on a multi-pass printer **208**. The IPU **204** includes a halftone generator **210**

including means for restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

The disclosed embodiments can also apply to a method of halftoning for multi-pass rendering in which different pixel locations are rendered in each pass. The method includes restricting a substantial majority of the pixels turned on to render a tone at an image location to the minimum number of passes required to produce the tone.

The method also includes generating a stochastic screen pixel turn-on sequence and partitioning the stochastic screen pixel turn-on sequence into a plurality of partitions with each partition corresponding to a different pass.

The pixels turned on to render a tone at an image location can be restricted to the minimum number of passes required to produce the tone by re-ordering the stochastic screen pixel turn-on sequence. The stochastic screen pixel turn-on sequence can be re-ordered to achieve this restriction by placing the lowest stochastic screen pixel turn-on sequence values in one partition and the highest stochastic screen pixel turn-on sequence values in another partition in the example of a two pass rendering using two partitions.

Also, the pixels turned on to render a tone at an image location can be restricted to the minimum number of passes required to produce the tone using error diffusion by providing an input image having a plurality of pixels each having an input tone value, partitioning the input image pixels into partitions wherein each partition corresponds to a different pass, adding an error diffused from previously processed pixels to the input tone value of a current pixel to achieve a desired pixel value, and comparing the desired pixel value with a threshold value, wherein the restricting step includes adding a zero mean bias signal to the input tone value based on the partition containing the input image pixel.

Also, the pixels turned on to render a tone at an image location can be restricted to the minimum number of passes required to produce the tone error diffusion by providing an input image having a plurality of pixels each having an input tone value, partitioning the input image pixels into partitions wherein each partition

corresponds to a different pass, adding an error diffused from previously processed pixels to the input tone value of a current pixel to achieve a desired pixel value, and comparing the desired pixel value with a threshold value, wherein the restricting step includes adding a zero mean bias signal to the threshold value based on which partition contains the input image pixel.

VI. Issues (37 C.F.R. §1.192(c)(6))

Whether claims 1-3, 25-26, and 28 are unpatentable under 35 U.S.C. §102(e) as being anticipated by Gotoh (US Patent Application Publication 2002/0024548 A1), hereinafter Gotoh.

Whether claims 4-10, 27 and 29 are unpatentable under 35 U.S.C. § 103(a) over Gotoh in view of Wang (US Patent 6,014,500).

Whether claims 11-14 are unpatentable under 35 U.S.C. § 103(a) over Gotoh in view of Wang (US Patent 6,014,500) and obvious engineering design choice.

Whether claims 15-24 and 30-31 are unpatentable under 35 U.S.C. § 103(a) over Gotoh in view of Shiau (US Patent 5,880,857).

VII. Grouping of Claims (37 C.F.R. §1.192(c)(7))

The claims at issue do not stand or fall together. Specifically, claims 1, 25 and 28 each recite separately patentable subject matter.

Claim 1 recites a method of halftoning for multi-pass rendering, wherein different pixel locations are rendered in each pass, the method comprising restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

Claim 25 recites a method of generating a stochastic halftone screen for multi-pass rendering, wherein different pixel locations are rendered in each pass, the method comprising restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

Claim 28 recites a system for halftoning for multi-pass rendering of an image having pixels, wherein different pixels are rendered in each pass. Claim 28 uses

means plus function language to define characteristics of the system claimed which claimed which necessitates one construing the meaning to the claim language to look to the specification. The system comprises means for restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

VIII.   Arguments (37 C.F.R. §1.192(c)(8))

The Examiner rejected claims 1-3, 25-26, and 28 under 35 U.S.C. §102(e) as being anticipated by Gotoh. The Examiner rejected claims 4-10, 27 and 29 under 35 U.S.C. § 103(a) over Gotoh in view of Wang. The Examiner rejected claims 11-14 under 35 U.S.C. § 103(a) over Gotoh in view of Wang and obvious engineering design choice. The Examiner rejected claims 15-24 and 30-31 under 35 U.S.C. § 103(a) over Gotoh in view of Shiau. The appellant respectfully disagrees.

1. Summary of Arguments

The Gotoh reference does not render unpatentable the subject matter recited in claims 1-3, 25-26, and 28. The combination of Gotoh and Wang does not render unpatentable the subject matter recited in claims 4-10, 27, and 29. The combination of Gotoh and Shiau does not render unpatentable the subject matter recited in claims 15-24 and 30-31. Details of Appellant's arguments are provided in more detail below.

2. Appellant's Arguments Re: Claim 1

This application, and the embodiments as claimed therein, relates to a method of halftoning for multi-pass rendering, wherein different pixel locations are rendered in each pass. The method comprises restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone. Claim 1 is patentable over Gotoh, since Gotoh does not teach or suggest this claim limitation.

In rejecting claim 1, the Examiner stated that in the example provided by Gotoh, half of the turned-on pixels are printed in two passes, with only one-quarter of the turned-on pixels being printed in a single pass, and thus three-quarters of the turned-on pixels are restricted from being printed. (The Examiner references Gotoh, paragraph 71). However, this is not claimed in claim 1, which claims restricting the substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

As described in paragraph [002] of the Background of the Appellants' application as filed, it is understood that most digital printers operate in a binary mode, i.e., for each tonal separation, a corresponding spot is either printed or not printed at a specified location or pixel. Digital halftoning controls the printing of tonal spots, where spatially averaging the printed spots of one or more tonal separations provides the illusion of the required continuous contone.

As described in paragraphs [045] – [046] of the Appellants' application as filed, the tonal intensity value, also known in the field of halftoning for image rendering as the tone, of the input image is used to determine which pixels are rendered, that is actually turned on resulting in a printed output, and those which remain off and thus are not printed. In the example provided in specification in paragraphs [029]-[046], which is simplified for clarity, a 2-bit image having a tone with a constant tonal intensity value of 25%, represented as 1 out of 0-3 was used. The restricting step was accomplished by re-ordering the pixel turn on sequence as shown in Figures 4 and 5, which was then converted to threshold values as shown in Figure 6. With a given tone of 25% tonal intensity value, for example, only the 1's are turned on or rendered resulting in black pixels represented by the cross-hatched squares **40** in the halftone output pattern **42** illustrated in FIG. 7. The black pixels **40** occupy *S*1 screen elements **24a** and are printed in only one pass making the rendered pattern less sensitive to inter-pass mis-registration than known methods of halftoning.

In section 1. of the Final Office Action containing the Examiner's reply to the Appellants' Response, the Examiner questioned what is considered the "minimum"

number of passes, stating that the "minimum" number of passes is different depending on the construction of each particular printing system. The Examiner stated that the minimum number of passes that a particular system requires to render a tone would read on the limitation disputed by the Appellants, whether that number of passes is 2, 10, 1000 or any other number of passes, and as such, the system taught by Gotoh using two passes uses the minimum number of passes and anticipates claim 1.

The Appellants respectfully maintain that claim 1 particularly points out and distinctly claims a patentable method of halftoning for multi-pass rendering. The claim limitation at issue is "the minimum number of passes required to produce the tone". This limitation must be read in the context of halftoning and multi-pass rendering. In the field of halftoning for multi-pass rendering, wherein different pixel locations are rendered in each pass, the minimum number of passes required to produce any particular tone depends on the number of passes the multi-pass system makes to render a tone of 100% tonal intensity value (i.e. a 2 pass system, 4 pass system, etc.) and the tonal intensity value of the tone being produced. For example, in a 4-pass rendering system, the minimum number of passes required to produce a tone having a tonal intensity value of 25% or less, is 1 pass.

Gotoh teaches a two pass multi-pass printing system, but uses both passes to render tones, regardless of tonal intensity value of the tone. Therefore, Gotoh does not teach or suggest a method of halftoning comprising restricting the substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

Gotoh teaches that divided recording processes of multi-pass printing using 2 passes may result in an imbalance in the number of nozzles used (see paragraphs [0076]-[0077]). However, this imbalance does not meet the claim limitation of restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

Gotoh seeks to provide greater uniformity of nozzle usage as discussed, for example, in paragraphs [0078]-[0082], among others. Gotoh teaches manipulating

the grayscale pattern shown in Figure 8 which consists of 8x16 dots for displaying 128 gray levels. This gray scale pattern consists of 2 blocks of gray scale patterns 8A and 8A' having 8x8 size as shown in Figure 25. The block 8A' formed by vertically divided blocks 8B and 8C. As shown in Figures 8 and 26, the block 8A' formed of blocks 8B and 8C is obtained by switching upper and lower blocks obtained by dividing blocks A into upper and lower blocks. In this way, the positions at which dots are concentrated in the respective block gray scale pattern shown in Figure 25 are scattered in the direction of array of the multinozzles 602 shown in Figure 17. As a result, the frequencies with which the multinozzles 602 are used become uniform and continuity of the gray scale can be enhanced. Therefore, Gotoh does not teach or suggest the invention as claimed in claim 1. Rather, by teaching the uniform use of print nozzles in this manner, Gotoh teaches away from claim 1 as claimed.

The Examiner has not provided prime facie support of Gotoh teaching this claim limitation as claimed in claim 1. Applicant maintains that Gotoh does not teach or suggest restricting the substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

For these reasons, claim 1 patentability defines over Gotoh and is therefore patentable. Further, claims 2-24 depending from claim 1 are also patentable.

3. Appellant's Arguments Re: Claim 2

Claim 2 is patentable over Gotoh, since Gotoh does not teach or suggest restricting approximately 75% or more of the pixels turned on to render a tone to the minimum number of passes required to produce the tone for the reasons stated above regarding claim 1.

The Examiner stated in the rejection of claim 2 that Gotoh teach restricting three-quarters (75%) of the turned-on pixels from being printed. However, this is not claimed in claim 2 which claims restricting approximately 75% or more of the pixels turned on to render a tone to the minimum number of passes required to produce the tone. Accordingly, claim 2 is patentable over Gotoh.

4. Appellant's Arguments Re: Claim 3

Claim 3 is patentable over Gotoh, since Gotoh does not teach or suggest restricting approximately 90% or more of the pixels turned on to render a tone to the minimum number of passes required to produce the tone for the reasons stated above regarding claims 1 and 2.

The Examiner stated the Gotoh reference discloses that in the case of 64 nozzles, only 1.5625% of the turned on pixels are printed with a single nozzle. Thus, more than 90% of the turned on pixels are restricted from being printed so that, with two sets of 32 nozzles a tone can be rendered in a minimum number of passes.

However, claim 3 claims restricting approximately 90% or more of the pixels turned on to render a tone to the minimum number of passes required to produce the tone. Gotoh teaches moving pixels to different print nozzles to create uniformity of nozzle usage, but it still teaches making 2 passes (using a plurality of nozzles in each pass) to render a tone regardless of the tone produced. Therefore, claim 3 is patentable over Gotoh for this reason and the reasons stated above with regards to claim 1.

5. Appellant's Arguments Re: Claim 25

Claim 25 is patentable over Gotoh, since Gotoh does not teach or suggest a method of generating a stochastic halftone screen for multi-pass rendering, wherein different pixel locations are rendered in each pass, the method comprising restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

The Examiner rejected claim 25, stating Gotoh teaches printing half of the turned-on pixels in two passes, and thus, only one-quarter of the turned on pixels are printed in a single pass. Therefore, three-quarters of the turned-on pixels are restricted from being printed.

However, this is not claimed in claim 25 which claims restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone. Claim 25, which claims a method of generating a

stochastic halftone screen for multi-pass rendering, is patentable for reasons similar to those stated with regard to claims 1-3 above.

The Examiner has not provided prime facie support of Gotoh teaching this claim limitation as claimed in claim 25. For these reasons, claim 25 patentably defines over Gotoh and is therefore patentable. Further claims 26-27, depending from claim 25, are also patentable over Gotoh.

6. Appellant's Arguments Re: Claim 26

Claim 26 is patentable over Gotoh since Gotoh does not teach or suggest partitioning a turn-on sequence into a plurality of partitions corresponding to rendering passes, wherein the restricting step includes re-ordering the pixel turn-on sequence to restrict a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

While Gotoh may teach re-ordering a pixel turn-on sequence, Gotoh does not teach restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone for the reasons stated with regard to claim 1-3 and 25 above. Accordingly, claim 26 is patentable over Gotoh.

7. Appellant's Arguments Re: Claim 28

Claim 28 patentably defines over Gotoh since Gotoh does not teach or suggest a system for halftoning for multi-pass rendering of an image having pixels, wherein different pixels are rendered in each pass, the system comprising, means for restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

The Examiner rejected claim 28 as being anticipated by Gotoh stating Gotoh discloses a system (shown in figure 16 and discussed in paragraph [049]) in which half the turned-on pixels are printed in two passes, and thus one quarter of the turned-on pixels are printed in a single pass. However, this is not claimed in claim 28 which claims means for restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

Claim 9 uses means-plus-function language to define the characteristics of the apparatus for computing properties of an image. In accordance with *In re Donaldson*, 16 F.3d 1189, 1193 29USPQ2d 1845, 1848 (Fed. Cir. 1994) the Federal Circuit has made it clear that means-plus-function language should be interpreted according to 35 USC 112 sixth paragraph. The court held "The plain and unambiguous meaning of paragraph six is that one construing means-plus-function language in a claim must look to the specification and interpret that language in light of the corresponding structure, material, or acts described therein..." As stated above with regard to claims 1-3 and 25-26, Gotoh uses 2 passes to render all tones whereas the minimum number of passes required to produce the tone in a 2-pass system depends on the tonal intensity value of the tone. For this reason, and the reasons stated with regards to claims 1-3 and 25-26, Gotoh does not teach the claimed limitation of means for restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

The Examiner has not provided prime facie support of Gotoh teaching this claim limitation as claimed in claim 28. Claim 28 patentably defines over Gotoh for the reasons stated above and is therefore patentable. Further claims 29-31, depending from claim 28, are also patentable over Gotoh.

8. Appellant's Arguments Re: Claims 4-10

The Examiner maintains that Gotoh teaches restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone, and the combination of Gotoh and Wang render claims 4-10 unpatentable.

Claims 4-10 patentably define over the combination of Gotoh and Wang since neither reference alone, or in combination, teaches restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone for the reasons stated above with regard to claim 1.

Further, with regard to claim 7 the Examiner stated Wang discloses placing the lowest stochastic screen pixel turn-on sequence values in one partition and the

highest stochastic screen pixel turn-on values in another partition (column 7, lines 30-40 of Wang). The Examiner further stated the stochastic screen pixel turn-on sequence values of Wang are partitioned into checkerboard and reverse-checkerboard partitions, and since the first half (S_1) of the turn-on sequence is in checkerboard form, then the first partition must be the lowest stochastic screen pixel turn-on sequence values and the second half (S_2) must be the highest stochastic screen pixel turn-on sequence values.

However, Wang does not teach this. Rather, Wang simply teaches that the stochastic screen S is divided into two subsets, subset (S_1) are the pixels contained in one half of the checkerboard pattern and subset (S_2) are the pixels contained in the other half of the checkerboard pattern. Wang does not teach that the half (S_1) contains the lowest turn-on sequence numbers and the half (S_2) contains the highest turn-on sequence numbers. Therefore, Wang does not teach a re-ordering step of placing the lowest stochastic screen pixel turn-on sequence values in one partition and the highest stochastic screen pixel turn-on values in another partition as claimed in claim 7 and claim 7 is patentable over the combination of Gotoh and Wang.

Further, with regard to claim 9, the Examiner stated Wang discloses re-ordering the stochastic pixel turn on sequence to optimize a merit function. However, Wang teaches the creation of a stochastic screen by optimizing a merit function, but does not teach re-ordering a stochastic pixel turn on sequence. Further, Wang does not teach obtaining a subsequence for each partition by arranging the pixels within the partition in increasing order of turn-on sequence values, concatenating the subsequences for the different partitions, in any order, to form a single sequence, and renumbering the resulting single sequence in increasing order of turn-on values to obtain the new turn-on sequence as claimed in claim 9.

Accordingly, claims 4-10 are patentable over the combination of Gotoh and Wang for these reasons.

9. Appellant's Arguments Re: Claims 11-14

Claims 11-14 are patentable over the combination of Gotoh and Wang and obvious engineering design choice because this combination does not teach the step of restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone for the reasons set forth above with regard to claim 1.

10. Appellant's Arguments Re: Claim 29

Claim 29 patentably defines over the combination of Gotoh and Wang since Gotoh does not teach or suggest means for partitioning the stochastic screen pixel turn-on sequence into a plurality of partitions each partition corresponding to a different pass, wherein the restricting means includes means for re-ordering the stochastic screen pixel turn-on sequence to restrict a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone for the reasons stated with regards to claims 1-3 above.

11. Appellant's Arguments Re: Claims 15-24

Claims 15-24 patentably defines over the combination of Gotoh and Shiau since Gotoh does not teach or suggest restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone for the reasons stated with regard to claim 1 above.

Further Shiau does not teach adding an error diffused from previously processed pixels to the input tone value of a current pixel to achieve a desired pixel value, and comparing the desired pixel value with a threshold value, wherein the restricting step includes adding a zero mean bias signal to the input tone value based on the partition containing the input image pixel as claimed in claim 15. The random noise Shiau adds does not provide a zero mean bias signal to the input tone value based on the partition containing the input image pixel.

Further Shiau does not teach adding an error diffused from previously processed pixels to the input tone value of a current pixel to achieve a desired pixel

value, and comparing the desired pixel value with a threshold value, wherein the restricting step includes adding a zero mean bias signal to the threshold value based on the partition containing the input image pixel as claimed in claim 15. The random noise Shiau adds does not provide a zero mean bias signal to threshold value based on the partition containing the input image pixel.

Accordingly, claims 15-24 are patentable over the combination of Gotoh and Shiau for these reasons.

CONCLUSION

In view of the foregoing, Appellant respectfully submits that claims 1-31 patentably define over Gotoh, alone and/or in combination with Wang or Shiau.

Accordingly, it is respectfully requested that the Examiner's rejections be reversed.

Respectfully submitted,

FAY, SHARPE, FAGAN,
MINNICH & McKEE, LLP

Date: <u>February 20, 2007</u>

Patrick D. Floyd, Reg. No. 39,671
1100 Superior Avenue
Seventh Floor
Cleveland, Ohio 44114-2518
(216) 861-5582

IX.   Appendix of Claims (37 C.F.R. §1.192(c(a))

1.   A method of halftoning for multi-pass rendering, wherein different pixel locations are rendered in each pass, the method comprising restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

2.   The method of halftoning defined in claim 1 wherein the substantial majority is approximately 75% or more of the pixels turned on to render a tone.

3.   The method of halftoning defined in claim 1 wherein the substantial majority is approximately 90% or more of the pixels turned on to render a tone.

4.   The method of halftoning defined in claim 1 further comprising:

generating a stochastic screen pixel turn-on sequence; and

partitioning the stochastic screen pixel turn-on sequence into a plurality of partitions, wherein each partition corresponds to a different pass.

5.   The method of halftoning defined in claim 4 wherein the restricting step includes re-ordering the stochastic screen pixel turn-on sequence to restrict a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

6.   The method of halftoning defined in claim 5 further comprising generating a stochastic halftone screen using the re-ordered stochastic screen pixel turn-on sequence.

7.   The method of halftoning defined in claim 5 wherein the re-ordering step includes placing the lowest stochastic screen pixel turn-on sequence values in

one partition and the highest stochastic screen pixel turn-on sequence values in another partition.

8.   The method of halftoning defined in claim 7 wherein the re-ordering step further includes:

a) replacing the lowest stochastic screen pixel turn-on value before re-ordering contained in one partition with a replacement value which is the lowest stochastic screen pixel turn-on sequence value of all partitions of the screen;

b) replacing the next lowest stochastic screen pixel turn-on value in the one partition with a replacement value which is the next lowest stochastic screen pixel turn-on sequence value of all partitions of the screen;

c) repeating step b) until the one partition is filled with the lowest stochastic screen pixel turn-on sequence values of all partitions; and

d) repeating steps a) through c) to re-order each of the other partitions in turn with the remaining unused replacement values.

9.   The method of halftoning defined in claim 7 wherein the re-ordering step further includes:

a) obtaining a subsequence for each partition by arranging the pixels within the partition in increasing order of turn-on sequence values;

b) concatenating the subsequences for the different partitions, in any order, to form a single sequence; and

c) renumbering the resulting single sequence in increasing order of turn-on values to obtain the new turn-on sequence.

10.   The method of halftoning defined in claim 5 wherein the partitioning step includes partitioning the stochastic screen pixel turn-on sequence into two partitions.

11.   The method of halftoning defined in claim 10 wherein the partitions are designated   S1   and   S2   and   the   merit   function   is $\widetilde{M}(S) = M(S) + w_1 * M(S1) + w_2 * M(S2)$, where $M(S)$ is a merit function suitable for a single stochastic screen and w_1 and w_2 are weighting factors in the range of 2 to approximately 100.

12.   The method of halftoning defined in claim 11 wherein the partitioning step includes partitioning into a checkerboard partition arrangement.

13.   The method of halftoning defined in claim 12 wherein the step of generating a stochastic screen pixel turn-on sequence includes generating a halftone screen for a checkerboard partition such that the pixels can be classified as belonging to the two partitions using the coordinates of columns and rows, *i* and *j*, and the mathematical rule

$$p(i,j) \in S1, \quad if(i+j)\%2 = 0;$$
$$p(i,j) \in S2, \quad if(i+j)\%2 = 1;$$
$$S = S1 + S2$$

and optimizing the merit function

$$\widetilde{M}(S) = M(S) + w_1 * M(S1) + w_2 * M(S2),$$

where w_1 and w_2 are weighting factors each in the range of approximately 2 to approximately 100.

14.   The method of halftoning defined in claim 13 wherein $w_1 \approx 3$ and $w_2 \approx 3$.

15.   The method of halftoning defined in claim 1 further comprising:

providing an input image having a plurality of pixels each having an input tone value;

partitioning the input image pixels into partitions wherein each partition corresponds to a different pass;

adding an error diffused from previously processed pixels to the input tone value of a current pixel to achieve a desired pixel value; and

comparing the desired pixel value with a threshold value, wherein the restricting step includes adding a zero mean bias signal to the input tone value based on the partition containing the input image pixel.

16.   The method of halftoning defined in claim 15 wherein the partitioning step includes partitioning the input image pixels into two partitions.

17.   The method of halftoning defined in claim 16 wherein the partitioning step includes partitioning the input image pixels into a checkerboard partition.

18.   The method of halftoning defined in claim 16 wherein the zero mean bias signal has a value of +D for one partition and -D for the other partition.

19.   The method of halftoning defined in claim 18 wherein the input image tone value can be one of 256 values and the value of D is between approximately 32 and 64.

20.   The method of halftoning defined in claim 1 further comprising:

providing an input image having a plurality of pixels each having an input tone value;

partitioning the input image pixels into partitions wherein each partition corresponds to a different pass;

adding an error diffused from previously processed pixels to the input tone value of a current pixel to achieve a desired pixel value; and

comparing the desired pixel value with a threshold value, wherein the restricting step includes adding a zero mean bias signal to the threshold value based on which partition contains the input image pixel.

21.   The method of halftoning defined in claim 20 wherein the partitioning step includes partitioning the input image pixels into two partitions.

22.   The method of halftoning defined in claim 21 wherein the partitioning step includes partitioning the input image pixels into a checkerboard partition.

23.   The method of halftoning defined in claim 21 wherein the zero mean bias signal has a value of +D for one partition and -D for the other partition.

24.   The method of halftoning defined in claim 23 wherein the input image tone value can be one of 256 values and the value of D is between approximately 32 and 64.

25.   A method of generating a stochastic halftone screen for multi-pass rendering, wherein different pixel locations are rendered in each pass, the method comprising restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

26.   The method of generating a stochastic halftone screen defined in claim 25 further comprising:

generating a pixel turn-on sequence; and

partitioning the turn-on sequence into a plurality of partitions corresponding to rendering passes, wherein the restricting step includes re-ordering the pixel turn-on sequence.

27.   The method of generating a stochastic halftone screen defined in claim 25 wherein the step of generating a pixel turn-on sequence includes optimizing a merit function representative of the halftone texture quality.

28.   A system for halftoning for multi-pass rendering of an image having pixels, wherein different pixels are rendered in each pass, the system comprising, means for restricting a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

29.   The system defined in claim 28 further comprising:

a stochastic screen pixel turn-on sequence generator; and

means for partitioning the stochastic screen pixel turn-on sequence into a plurality of partitions each partition corresponding to a different pass, wherein the restricting means includes means for re-ordering the stochastic screen pixel turn-on sequence to restrict a substantial majority of the pixels turned on to render a tone to the minimum number of passes required to produce the tone.

30.   The system defined in claim 28 further comprising:

means for partitioning an input image having a plurality of input pixel tone values into a plurality of partitioned pixel tone values;

means for processing the partitioned pixel tone values to produce a previously processed pixel error diffusion value;

means for processing a current partitioned input pixel tone value including means for adding the previously processed pixel error diffusion value to the current partitioned input pixel tone value to achieve a desired pixel value; and

means for comparing the desired pixel value with a threshold value to produce an output signal for rendering the image, wherein the means for restricting includes means for adding a zero mean bias signal to the current partitioned input pixel tone

value, the zero mean bias signal being based on the partition containing the partitioned pixel tone value.

31.   The system defined in claim 28 further comprising:

means for partitioning an input image having a plurality of input pixel tone values into a plurality of partitioned pixel tone values;

means for processing the partitioned pixel tone values to produce a previously processed pixel error diffusion value;

means for processing a partitioned input pixel tone value including means for adding the previously processed pixel error diffusion value to the partitioned input pixel tone value to achieve a desired pixel value; and

means for comparing the desired pixel value with a threshold value to produce an output signal for rendering the image, wherein the means for restricting includes means for adding a zero mean bias signal to the threshold value, the zero mean bias signal being based on the partition containing the partitioned pixel tone value.

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